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By- Dobrovolny, Jerry S. Hartley, Thomas C.

UPGRADING OF HIGH SCHOOL DRAFTING TEACHERS, AN EIGHT-WEEK SUMMER TRAINING PROGRAM TO UPGRADE SUBJECT MATTER COMPETENCY OF HIGH SCHOOL DRAFTING TEACHERS IN ADVANCED GRAPHICS, STATICS, AND APPLIED MATHEMATICS. FINAL REPORT.

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An 8-week summer institute was conducted in 1967 by the University of Illinois College of Engineering to upgrade the professional competence of 24 high school drafting teachers from 15 states, and to estimate how many of such a group, after study in this and related programs, could successfully move into teaching technical institute level courses in mechanical technology and machine design. The program consisted of 24 class hours weekly in 3 courses: Applied Mathematics for Mechanical Systems, Introduction to Design, and Seminar in Technical Education. Courses were paced flexibly since participants' backgrounds were in education with no engineering sciences and limited mathematics. About 1/3 of the enrollees demonstrated enough capability in mathematics that success could be predicted in further study of mathematics or engineering science requiring mathematics. About 1/2 handled well the work in advanced production and design dimensioning, and 1/3 clearly showed success in work in graphics and analytical statics, fundamental for kinematics or machine design. The seminar elicited group lament that past education courses had left them with little depth in technical subject matter to be taught. There was collective enthusiastic endorsement of the institute and recommendation for its continuance and extension into programs of four summers' duration. Appended are the class schedule, publicity materials, and a list of participants. (Author/JS)

FINAL REPORT
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AN EIGHT-WEEK SUMMER TRAINING PROGRAM TO UPGRADE SUBJECT MATTER COMPETENCY OF HIGH SCHOOL DRAFTING TEACHERS IN ADVANCED GRAPHICS, STATICS, AND APPLIED MATHEMATICS

Conducted by the Department of General Engineering
University of Illinois, Urbana, Illinois.

SEPTEMBER, 1967

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Office of Education
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Jerry S. Dobrovolny
Thomas C. Hartley

University of Illinois
Urbana, Illinois 61801
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U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

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I. SUMMARY

An eight-week Summer Institute was conducted by University of Illinois Department of General Engineering staff members to (1) upgrade the professional competence of twenty-four high school drafting teachers from fifteen states, and (2) to estimate what portion of such a group, after study in this Institute and a further program of study in mathematics, engineering sciences, and mechanical design, could successfully move into teaching technical institute level courses in mechanical technology and machine design.

There were twenty-four class hours weekly in three courses: Applied Mathematics for Mechanical Systems, Introduction to Design, and Seminar in Technical Education. Courses were taught with structure, methods, and rigor as would be followed for engineering students, but with special attention to course pacing.

Enrollees' backgrounds were almost exclusively in Education, with no engineering science background, very limited mathematics, and an aver ge of over ten years since the baccalaureate degree. Hence, despite generally excellent participant attitudes toward professional growth and the Institute course work, great adjustment of pace was needed in mathematics and in design.

About one-third of the enrollees demonstrated sufficient capability in mathematics to justify the expectation they could successfully study more mathematics and engineering sciences utilizing mathematics. About one-half of the participants were qualified for, and handled well, the advanced work in production and design dimensioning, and one-third clearly showed success with work in graphical and analytical statics, a fundamental requisite for any subsequent study in kinematics and machine design.

The seminar course evoked enthusiastic discussion of philosophy of technical education, teacher preparation, problems of articulation, and federal legislation and its effects. Very significantly the group expressed, at times emotionally, the fact that their past Education courses had proved consistently inadequate in providing the necessary depth of learning in subject matter to be taught.

The conclusion of the Institute staff and participants was that (1) all the drafting teachers were able to profit from the Institute program to better fulfill their present responsibilities, and (2) a sizable portion of the group showed great capability for further successful study in mathematics and engineering courses. There was, therefore, collective, enthusiastic endorsement of the

Institute program and recommendation for its continuance and extension into a program of four or more summers' duration, permitting study of thirty to forty credit hours of engineering science, mathematics, and mechanical engineering courses, and thereby providing the necessary learning to be thoroughly competent in teaching post-high school mechanical technology.

II. INTRODUCTION

There is currently an acute shortage of well qualified instructor personnel to staff the many post-high school programs in mechanical technology which are emerging throughout the country. The impact of the federal Vocational Education Act of 1963 has been to place increased emphasis on these and other technical programs and to increase the demand for capable instructors now and for additional thousands in the future. At the same time, the entrance of high school graduates into such programs and their success in them will be greatly aided by the strongest possible preparatory technical courses in high school. Therefore, it is highly desirable that high school teachers, especially in technical areas, be as professionally competent and up-to-date as possible.

As an approach to meeting both these needs, the Department of General Engineering at the University of Illinois conducted in the summer of 1965 an eight-week Summer Institute for high school drafting teachers, offering subject matter courses in technical mathematics, certain aspects of advanced graphics, introductory work in statics and design, and a seminar in technical education. There were two major objectives:

OBJECTIVE 1: TO UPGRADE THE PROFESSIONAL COMPETENCE OF HIGH SCHOOL TEACHERS OF DRAFTING IN THEIR PRESENT TEACHING AREA.

It was expected they would be better qualified to teach existing courses at their respective schools, and would be able to add to and upgrade the material offered in those courses or to offer more advanced courses in graphics. They would also be better qualified to pursue additional locally available subject matter training in night school, extension courses, or regular college courses, or in subsequent summer institute programs if available.

OBJECTIVE 2: TO MAKE AN ESTIMATE, BASED ON THE SUCCESS OF THE TEACHERS IN THIS PROGRAM, OF THE ABILITY OF SUCH TEACHERS TO SUCCEED IN POSSIBLE FUTURE INSTITUTE PROGRAMS OFFERING COURSES IN MATHEMATICS, ENGINEERING SCIENCES, AND MECHANICAL DESIGN.

Success in such additional courses as these would make one very well qualified to teach post-high school mechanical technology. It was desirable, therefore, to assess the attributes of typical high school drafting teachers and to estimate the desirability and feasibility of possible future institute programs for preparing high school drafting teachers to move into teaching positions in mechanical technology.

III. METHODS

1. Selection of Participants

The Institute proposal was approved May 1, 1965. Due to the lateness of the announcement, the deadline for submitting applications was June 1, 1965. Therefore, there were only three weeks of time available for disseminating information about the program.

Announcements and applications were sent to each of the State Directors of Vocational Education, as well as applicants to and past participants in the five previous Summer Institute programs sponsored by the National Science Foundation and conducted by the University of Illinois for technical institute and junior college teachers.

By June 1 there were 102 completed applications in hand for consideration by the screening committee. The large number of responses was particularly gratifying to the director since there had been such a short time for advertising the program. It points out the fact that there is a very great need for this type of funded teacher-training activity which provides stipends for the participants.

Twenty-five participants were selected. The general criteria for selection were that the participants should hold a baccalaureate degree, should have completed one year of college physics, and should have completed one semester of college algebra and college trigonometry. All twenty-five participants reported on campus; however, one of the participants could not complete his registration procedures since he was called home on a matter of personal business. He was unable to return to the program, and due to the lateness of his cancellation it was impossible to replace him with an alternate.

Included in the Appendix are copies of the announcement brochure and the application blank developed for Institute use. The roster of participants is also included therein.

2. Content of Institute Program

The courses offered in the program were designed to assist faculty members of high school technical drafting departments in extending and upgrading their subject matter competencies, specifically in drafting. They were also planned to include additional subject matter in order to stimulate the teachers' motivation and meet the needs and interests of teachers who might desire to undertake

more advanced teaching assignments in post-high school mechanical technology curricula in technical institutes and junior colleges. Eight semester hours of credit were earned by the participants. The courses were of college level and the technical subject matter was constituted from selected topics normally covered in the lower division years of an engineering curriculum.

Brief descriptions of the courses follow:

G.E. 221M (3 hours) - Introduction to Design

The first half of this course presented the most recent practices in production dimensioning, including positional and geometric form tolerancing. Emphasis was placed on dimensioning practices used in the highly automated machine tool industry. The second half of the course was devoted to basic concepts of statics and included such topics as vectors, free body diagrams, equilibrium of forces in space, and static force systems as in machine members and frames. Both graphical and analytical methods of solution were presented.

G.E. 293 (4 hours) - Applied Mathematics for Mechanical Systems

This course was presented to provide the necessary mathematical subject matter and methods for participants to be able to do course work in statics and dynamics and included the following topics: elementary functions, exponents and radicals, logarithms, quadratic equations, simultaneous equations, properties of vectors, systems of equations, and elements of plane trigonometry.

G.E. 393S (1 hour) - Seminar in Technical Education

The seminar was concerned with the history and philosophy of post-high school technical education as a part of the training of the overall engineering manpower team. The recent report by the American Society for Engineering Education entitled, "Characteristics of Excellence in Engineering Technology Education," was analyzed in detail. The increasingly critical importance of mathematics and of science-oriented programs for engineering technicians was stressed. Specialists presented lectures on such topics as curriculum development, financing, job opportunities, counseling, testing procedures, and other pertinent subjects.

Included in the Appendix is a detailed list of specific topics presented in the two subject matter courses and the approximate class time allotted to each.

3. Course Methods

G.E. 221M (3 hours) - Introduction to Design

The course met twelve hours per week for eight weeks. The first four weeks of the course were devoted to modern design and dimensioning practices for production drawings of machined parts. One period was taken for registration and orientation and one period for mid-semester examination. Three short quizzes were given. All other sessions consisted of lectures, discussions, and laboratory practice.

Homework problems and class problems were assigned from printed workbooks in the subject matter area. The course began with a review of standar orthographic projection theory, conventional practices in object representation, and general considerations involving tolerances and allowances in the calculation of limit dimensions for different types of fit and function. Problems were then undertaken considering both interchangeable assembly and selective assembly, selection of datum planes, and the maximum material concept. Advanced practices presented included the three plane concept, positional tolerances and tolerance zones, geometric form tolerances and toleran zones, and the specification of surface quality.

The last four weeks of the course dealt with statics, using both graphical and analytical methods of solution. Since trigonometry is needed so frequently, some time was spent reviewing trigonometric methods. The course then covered vectors, free body diagrams, two-dimensional force systems, equilibrium of forces in space, and analysis of frames and simple trusses.

For daily homework the students were given a reading assignment and a problem pertaining to the reading assignment or to the preceding lecture. The problem was to be turned in at the beginning of the next meeting. Each two-hour class session usually consisted of one hour for lecture or discussion and one hour for supervised problem solving.

G.E. 293 (4 hours) - Applied Mathematics for Mechanical Systems

The course in applied mathematics met eight hours per week, for eight weeks, and covered fundamental topics in college algebra and trigonometry. In most class sessions a formal presentation of new material or review of old material was made by the instructor. Following this, there was great daily emphasis on solving of quantities of varied and suitable problems at

blackboards around the room, mostly by the class. It was felt that in learning mathematics there is no substitute for the exercise or drill of solving quantities of problems, and doing a considerable amount of this in class kept all the students thus active. In addition, the student interaction and alternative student-phrased explanations which were produced were valuable in clearing up questions and contributed greatly to class morale. In addition to the blackboard problems, daily homework assignments were made of both reading and problems.

During the first class session a pre-test was given consisting of a mathematics placement test already in use at the university. Four topical problem-type hour quizzes were given during the eight-week session, and as a final exam and post-test the mathematics placement test was again administered. Also during the summer the Q.E.D. test (Quantitative Evaluation Device, by Dr. R. E. Stake) was taken by the class.

There was interest on the part of some class members in studying slide rule theory and operation. Therefore, several extra class sessions were conducted for those who wished to attend. Problems and demonstration materials were furnished for student usage as desired.

G.E. 393S (1 hour) - Seminar in Technical Education

The seminar class met for two two-hour sessions each week for the purpose of studying and discussing the history and development of technical education and current trends and problems in the field. New curricula and programs of technical education were discussed, with particular emphasis on articulating high school drafting programs and post-high school programs in engineering technology. The increasing importance of mathematics and science in modern technical education was stressed.

Guest speakers invited to the seminar sessions included Mr. Walter Bartz, Chief of Technical Education for the State of Illinois, discussing the programs implementing technical education in the state. Dr. Helmut Aigner, from Austria, made a presentation on technical education in Europe. Mr. Leslie J. Wilson, Vice President of Addison-Wesley Publishing Company, made a presentation on writing textbooks for technical education. In addition, guest speakers were invited to discuss techniques for presentation of some of the more difficult topics in engineering graphics. Special techniques in blackboard teaching were discussed by Professor Wayne L. Shick,

and a presentation was made by Dr. Robert P. Borri on achievement testing as it applies to constructing examinations for courses in engineering drawing.

Laboratories in the College of Engineering at the university were visited to acquaint the teacher-participants with the kinds of experiences that engineering students have in their undergraduate and graduate study in engineering and engineering sciences.

The group of participants was divided into five panels, with each panel developing a paper which was presented and distributed to the members of the class. Panel topics presented were as follows:

Panel 1 - The Philosophy of Technical Education

Panel 2 - Teacher Preparation

Panel 3 - Federal Legislation

Panel 4 - Articulation with Junior Colleges and Senior Colleges

Panel 5 - The High School Drafting Curriculum

Throughout the entire Institute, participation in the seminar course was active and enthusiastic and many significant items were brought up during the panel discussions. Enrollees generally agreed on the great value to them of the opportunity for meeting and talking with others in secondary school technical education from other institutions and other parts of the country. A great deal of such interaction was stimulated by the seminar.

Perhaps the most important single item brought out was the collective agreement by the participants that <u>teacher training in co.leges of education is consistently inadequate in providing the necessary depth of learning in subject matter to be taught</u>. The feeling generally expressed was that excellence in pedagogy or structure or philosophy of public education does not obviate the need for sound and concentrated learning of one's subject matter field. The views representing the consensus of the seminar group will be reported and further commented upon in the section of the report dealing with recommendations.

IV. RESULTS AND EVALUATIONS

1. Course Evaluation: G.E. 221M - Introduction to Design

The first four weeks of the course dealt with advanced practices in detail design and production dimensioning. About one-half of the enrollees had a background which made them well qualified for this work. All of these seemed extremely interested in the up-to-date information presented on modern industrial practices in dimensioning and tolerancing. Several requested a bibliography of modern books and articles in this area and indicated plans for informal study on their own. Although for a few of the enrollees some of the specific problems were too easy, all completed the work without complaint. It is believed that all enrollees profited from the work and are now able to introduce new materials into their local courses. Previous preparation, however, helped determine the amount of individual achievement.

The second four weeks of the course dealt with principles of statics, treated by both graphical and analytical methods of solution. In this portion of the course there was a greater spread in individual achievement. The enrollees came into the course with similarly weak or at least rusty mathematics backgrounds. However, their ability to refresh their past learning and to apply mathematics in the course varied greatly and was largely responsible for the varied achievement. It is believed that a thorough review of plane trigonometry completed prior to beginning the last half of the course would have been beneficial to all.

Based on the comments of the students and the judgment of the instructors it is believed all enrollees profited and felt the subject matter was worthwhile to them, meriting its inclusion in the Institute as material basic to mechanical technology. It is felt about one-third of the students showed sufficient ease of learning the material to justify the prediction that they could be successful in subsequent courses in engineering sciences or in mechanical engineering courses such as kinematics and machine design.

2. Course Evaluation: G.E. 293 - Applied Mathematics for Mechanical Systems

The participants were given a mathematics qualifying examination during the first day of the program. Scores generally were very low, as was to be expected, considering most participants had very limited college mathematics, and it had been little used in recent years. They were given the same qualifying examination at the completion of the mathematics course to determine the effectiveness of the

course and the ability of the participants to absorb the material. Marked improvement was shown by most course enrollees. Results are presented in Figure 1 on page 11. The pre-test mean score was 14 on a 60 item test, and the post-test mean was 23. Pre-test to post-test gains are shown in Figure 2 on page 12. The average pre-test to post-test gain for all men was 10.8 points. The seven men who were above the pre-test mean score had a 12.1 point average gain on the post-test mean score. Sixteen men who were below the pre-test score mean had a 10 point average gain on the post-test mean score. It is apparent that those who had scored higher on the pre-test showed more gain than the others.

There seemed to be no relationship between earlier college grades in algebra and trigonometry and scores on either the pre-test or post-test. This is reasonable considering the differences in the various courses previously taken by the participants from various colleges and universities, and varying amounts of time since graduation.

An attempt was made to measure quantitative abilities of the participants of the type felt necessary to work successfully in courses which deal with analysis, synthesis and design. A quantitative evaluation device, the Q.E.D. test, developed by Dr. Robert E. Stake at the University of Nebraska, was administered to the participants. It was designed to predict the competence with which the student will handle the quantitative aspects of study or research. It is felt to be useful in measuring ability in certain aspects of data treatment, graphical or symbolic presentation of data or other ideas, deductive and inductive reasoning, statistical inference and in the definition and categorization of symbols, words, and concepts. The mean score for the Institute group was 23 out of 65 items. This mean compares favorably with the mean score obtained from 925 post-baccalaureate persons desiring to qualify as graduate students in Education at the University of Nebraska, but was somewhat lower than the mean of a group of technical students with more background in mathematics.

The results of the Q.E.D. test were compared with the grades obtained in the four quizzes in mathematics which the participants took during the semester, two in algebra and two in trigonometry. There was a high relationship between the average percentage score on these quizzes and the Q.E.D. test score. The Spearman Rho, or rank-order correlation was 0.78 indicating quite a large correlation between these two measures.

DISTRIBUTION OF MATHEMATICS PRE-TEST AND POST-TEST SCORES

U.S.O.E. INSTITUTE, UNIV. OF ILLINOIS, SUMMER 1965

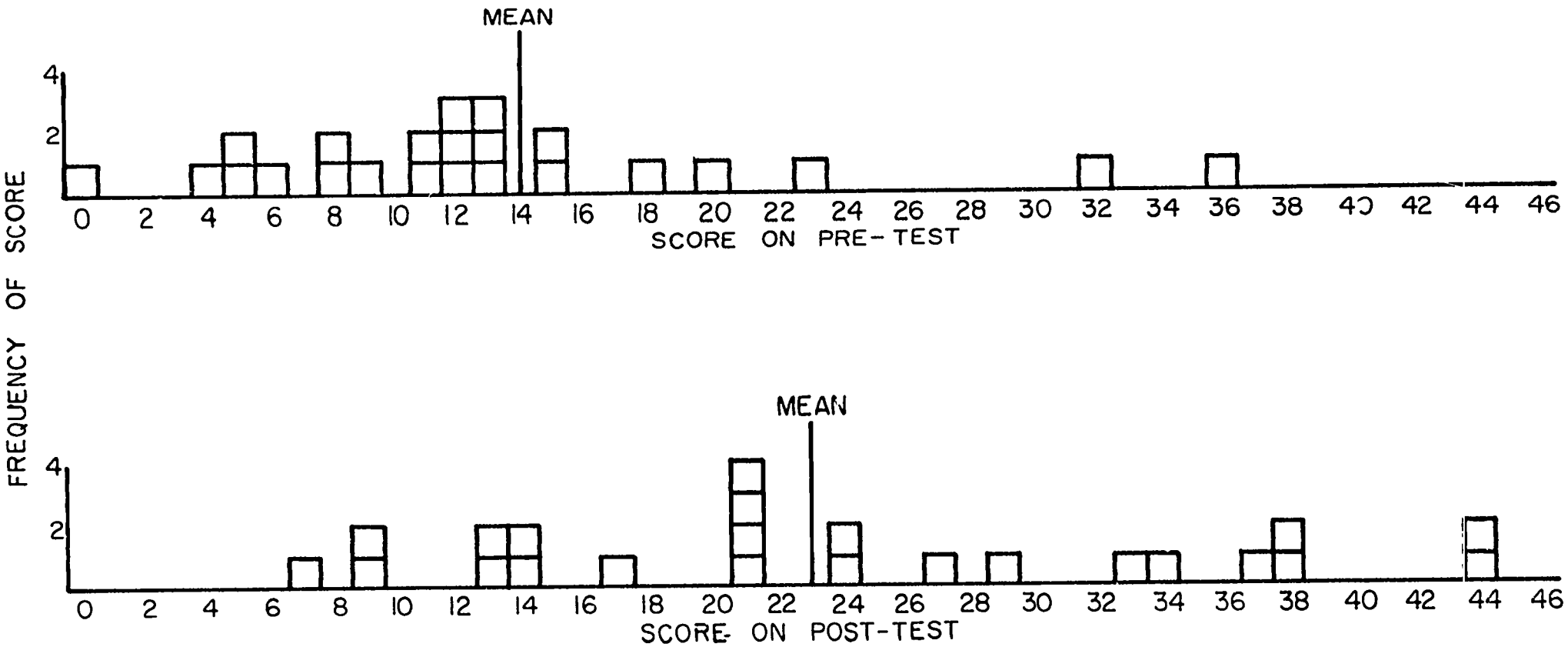


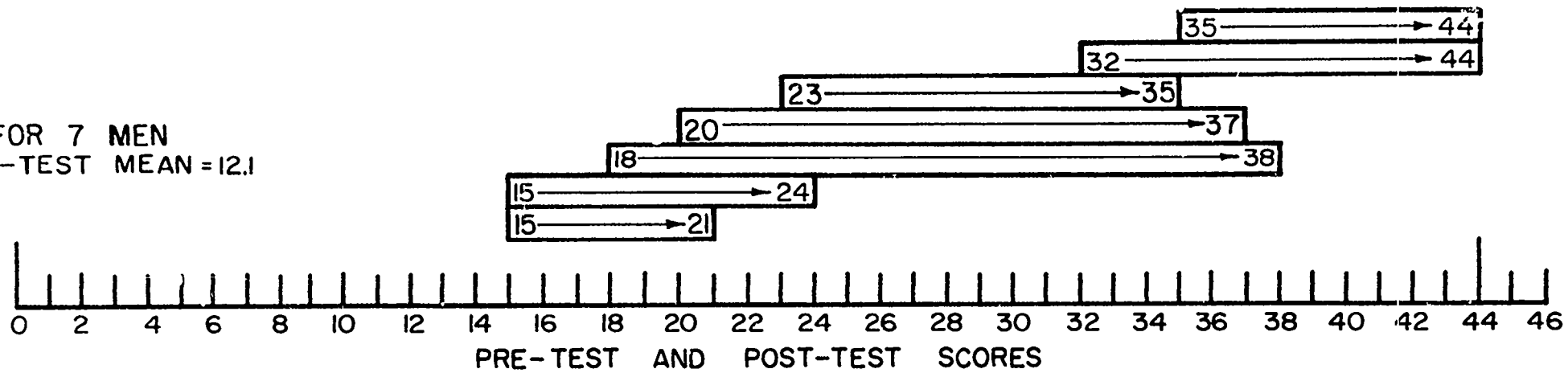
FIGURE 1

GRAPHICAL REPRESENTATION OF PRE-TEST TO POST-TEST CHANGES IN SCORE IN MATHEMATICS

U.S.O.E. INSTITUTE, UNIV. OF ILLINOIS
SUMMER 1965

PRE-TEST MEAN SCORE: 14
POST-TEST MEAN SCORE: 23
AVE GAIN PRE TO POST FOR ALL: 10.7

AVE. GAIN FOR 7 MEN
ABOVE PRE-TEST MEAN = 12.1



AVE. GAIN FOR 16 MEN
BELOW PRE-TEST MEAN = 10
(OMITTING 1 MAN WHO SHOWED NET LOSS, 15 MAN AVE GAIN = 11)

(THIS MAN SHOWED PRE-POST TEST LOSS)

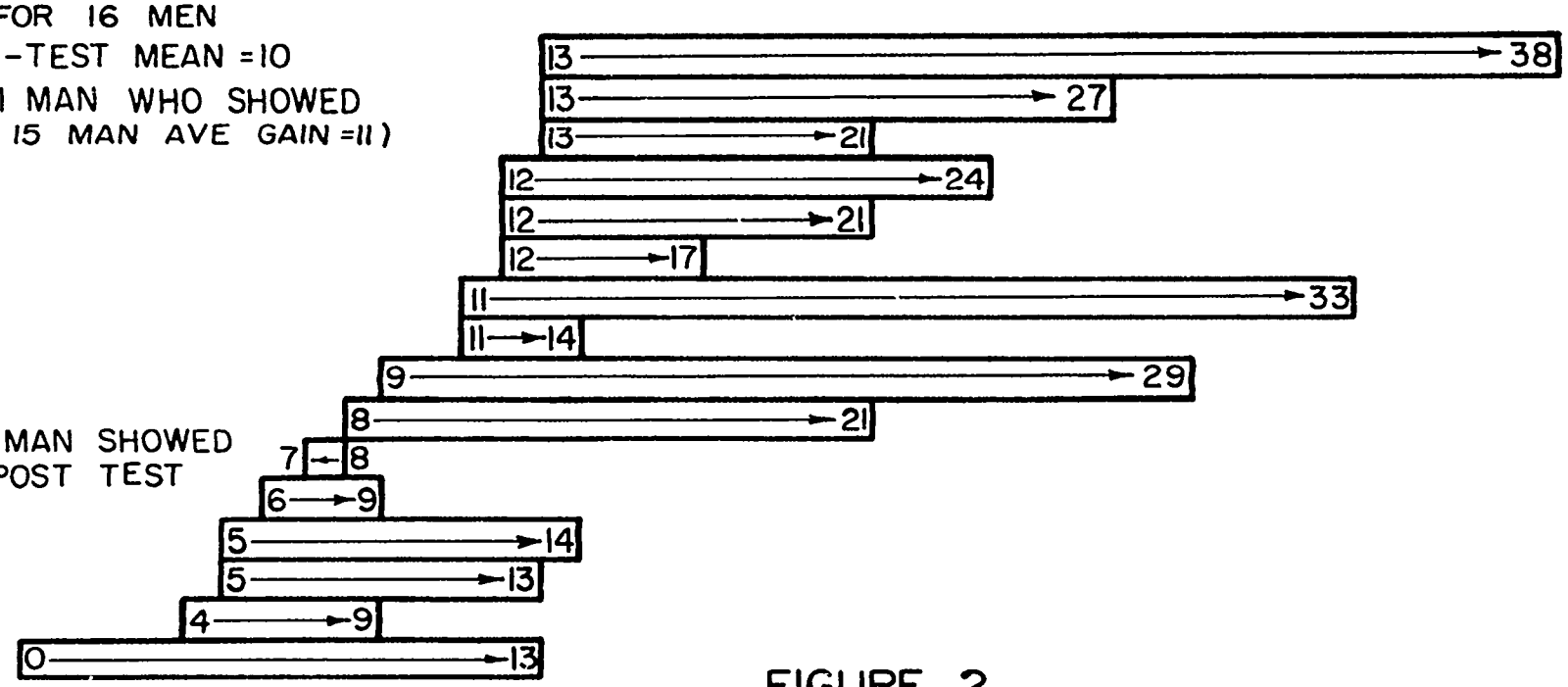


FIGURE 2

It was felt that about one-third of the group indicated sufficient mathematical ability and achievement to justify a prediction of success in future courses in mathematics through calculus or in engineering science courses which would utilize mathematics.

To the staff members of the Institute, the achievement in mathematics, specifically algebra and trigonometry was seen to be the best available index to possible success in any future college level courses in engineering science or mechanical engineering. Non-engineers can hardly imagine the amount of day-to-day routine mathematics used in an engineering curriculum and in engineering practice. This is not to say all mechanical technology teachers or even all engineers must be mathematicians, but they must be capable of handling relatively routinely a great amount of mathematics including differential and integral calculus.

3. Course Evaluation: G.E. 393S - Seminar in Technical Education

As was stated earlier in the report, the enrollees participated actively and enthusiastically in the panel discussions and other discussions throughout the seminar. The opportunity for interaction with others in the field from elsewhere in the country, much of which carried over from the seminar class into their housing after hours, was felt by all to be particularly valuable.

The greatest tangible factual enlightenment probably came in the greater realization by the enrollees of how increasingly essential mathematics (including calculus) and engineering sciences (physics, mechanics, etc.) are to modern curricula in engineering technology, in two-year programs almost as much as in four-year programs. Since their own backgrounds were non-engineering, many had not previously realized the extent to which mechanical technology and mechanical design are solidly based on these technical disciplines.

Another frequently heard comment was that many enrollees, even though they were active and experienced teachers, had no real notion of the breadth and quantity of technical education in the country, the opportunities which it offers, and the challenges which it presents in our dynamic society. Hence, personal awakening for many must be considered an important achievement of the Institute.

Probably the most universal expression heard from the participants was their conviction that the depth of subject matter presented in college of education teacher training programs was consistently inadequate for preparation of graphics

teachers at any school level. Most of the participants held a Master's degree in Education and had from ten to fifteen years of teaching experience. Still they expressed themselves forcefully, and at times emotionally, in lamenting the fact that in neither their undergraduate nor graduate preparation had they found possible the depth of concentration on subject matter which they were sampling in this Institute. It was strongly felt by most that post-baccalaureate programs were needed to strengthen their unders anding of orthographic projection heory, graphical computation, advanced design and production dimensioning, positional and geometric form tolerancing, all of which topics are well within the subject matter area of graphics in which they were teaching. And to move successfully into teaching advanced graphics courses or mechanical technology and design, it would be absolutely necessary for further study in graphics and in analytical statics, dynamics, kinematics and other engineering sciences intrinsic in machine design.

It must be concluded, therefore, that the seminar was an unqualified success in enlightening Institute participants and in motivating them to undertake greater personal and professional growth.

4. Participant Reaction to the Total Institute

As described above, there was an overwhelmingly favorable reaction to the program on the part of the participants. The question that was asked repeatedly was, "Why haven't programs like this been available previously for teachers like us?" The background of most of the persons in attendance was an industrial arts background. All of the participants concurred that they had not had adequate depth of subject matter preparation in their undergraduate teacher training to enable them to perform their tasks satisfactorily in present teaching responsibilities.

One of the significant points that was brought out in the seminar discussions was the fact that without the stipend support the participants could not have attended the Institute due to the severe financial strain which would be incurred by their families as a result of their not being employed during the summer to supplement the modest salary most were earning.

Some of the participants were motivated to continue immediate additional upgrading activities. One of the participants resigned his teaching position and has completed a Master's degree program in Industrial Education. Others indicated their firm intention to enroll in extension courses or correspondence courses, or to attend classes at colleges or universities in their local areas.

V. CONCLUSIONS AND RECOMMENDATIONS

1. General Comments

The high school drafting teachers who were the student participants in this Institute differ noticeably from engineering students in background preparation and previous orientation. As a group, their overall mental ability was felt to be very high, and their verbal ability was undoubtedly considerably greater than that of most engineering students. The chief difference seemed to be the lack of previous background and experience in problem-solving type courses such as engineering students receive in studying mathematics and engineering science. Since college work in Education tends to concentrate on teaching methodology, philosophy and other educational considerations, this difference is easily understandable. Also since much of their teaching experience has been with courses teaching manipulative skills, their work may be described as largely that of passing along relatively mechanical learned skills. The learning involved in high school vocational and technical courses is generally of a lower cognitive order than problem-solving, analysis or design.

An example of another difference in orientation was reflected in the comments by some teachers on the difficulty and newness to them of having text assignments and home problems in advance of class presentations, their previous formal learning experience having been that the initial contact with new material was in class presentation or demonstration, followed by home study or shop practice.

These comments are not meant to imply that the participants were incapable of problem-solving or resentful of methods used, but simply that the Institute presented different-than-usual kinds of activities for them. The progress made by most of the participants in the courses was very good under the circumstances, and their motivation and willingness to spend time and work hard was outstanding. To those with little and/or far removed previous mathematics, the mathematics course proved rather difficult at first and was distressing to some. But as renewal of old learning came along, there was considerable enthusiasm for the work. It is felt practically all would be willing and interested in further institute work if there were to be another such opportunity, although it is true they would not all benefit equally nor achieve equally from such further study.

2. Conclusions

As indicated in the individual course evaluations above, the Institute was basically very successful. It is felt that the two primary objectives were achieved.

OBJECTIVE 1: TO UPGRADE THE PROFESSIONAL COMPETENCE OF HIGH SCHOOL TEACHERS OF DRAFTING IN THEIR PRESENT TEACHING AREA.

With regard to specific upgrading of competence in teaching modern graphics, it is felt all enrollees profited, some to a larger extent than others. It is also felt that limited specific professional needs can very readily be met by institutes of this nature serving relatively homogeneous groups of teachers needing up-to-date subject matter material. Indeed there is a great deal of additional material in graphics which could be disseminated through further institutes of this type. And, of course, specific needs in other subject matter areas can and are being alleviated in this manner.

OBJECTIVE 2: TO MAKE AN ESTIMATE, BASED ON THE SUCCESS OF THE TEACHERS IN THIS PROGRAM, OF THE ABILITY OF SUCH TEACHERS TO SUCCEED IN POSSIBLE FUTURE INSTITUTE PROGRAMS OFFERING COURSES IN MATHEMATICS, ENGINEERING SCIENCES, AND MECHANICAL DESIGN.

As indicated in subject matter course evaluations, it is felt that about one-third of the Institute enrollees showed sufficient achievement to predict success for them in such possible future courses. By this is meant they could reasonably be expected to do as well as the average engineering student does in these courses. And it should be repeated that a sequence of as many technical courses as possible, up to perhaps thirty to forty credit hours, would be essential to successful teaching in mechanical technology. It is apparent that any plan for an extended upgrading program should provide for about two-thirds attrition between the first and second institutes and for a lesser attrition between subsequent summer sessions.

A further obvious conclusion is that without summer or academic year institutes of this type, furnishing stipends as generous as possible to cover personal and family expenses of participants, a meaningful amount of progress in upgrading of these teachers is well nigh impossible for them to accomplish. Many are from localities where regular term courses are not available, or are taught at a level for which they are not yet ready. Others have no time for such study, during either the school year or the summer, being obliged to "moonlight" with extra work either in their school system or outside it in order to augment their incomes.

3. Recommendations

(1). Based on the success of this and other similar institutes it is recommended that single-term institutes be continued to meet specific subject matter needs within a teaching area for relatively homogeneous groups of teachers with similar needs.

(2). Since large amounts of study are needed to enable a high school graphics or general industrial arts teacher to move up to the level of technical institute curricula in mechanical technology, it is strongly recommended that multi-term institutes be offered and supported for those teachers interested in and capable of successful study in mathematics and engineering sciences. Most of the Institute participants urged the Director and staff to conduct such a program. It is estimated that several thousand teachers presently in high schools could gradually move into higher level post-high school technology curricula under such programs, and thus substantially reduce the shortage of qualified teaching personnel in these curricula.

(3). It is further recommended that in the support of institutes of both types, participants should receive personal and family stipends as generous as possible. This is not only reasonable, but absolutely realistic in that without them the caliber of personnel desired simply will not be obtainable to participate in such upgrading programs.

APPENDIX A

DETAILED LIST OF TOPICS IN SUBJECT MATTER COURSES

G.E. 221M - Introduction to Design

Spatial Relationships of Geometrical Forms	10
Datum Planes	4
Fundamentals of Production Dimensioning	12
Tolerance Zones	12
Geometrical and Form Tolerancing	4
Surface Quality Specification	3
Fundamentals of Vectors	6
Fundamental Concepts of Equilibrium	4
Free Body Diagrams	4
Simple Force Systems	8
Concurrent Forces in a Plane	7
Parallel Forces in a Plane	7
Non-Concurrent Coplanar Forces	15
	96 hours

G.E. 293 - Applied Mathematics for Mechanical Systems

Numerical Computations	3
Basic Algebraic Operations	8
Equations	10
Exponents and Radicals	8
Quadratic Equations	5
Logarithms	6
Right Triangle Trigonometry	8
Simultaneous Equations	5
Continuation of Trigonometry	11
	64 hours

TIME SCHEDULE OF CLASSES

The operation dates of the training program were for eight weeks, from June 21 to August 14, 1965. The weekly schedule was as listed below:

Course No.	Times	Contact Hours Per Week	Course Title
G.E. 221M	8-10 M W F 8-11 T T	12 hours	Introduction to Design
G.E. 293	1-3 M W F 1 T T	8 hours	Applied Mathematics for Mechanical Systems
G.E. 393S	2-4 T T	4 hours	Seminar in Technical Education

Seminars on Technical Education--GE 393S--
1 hour

Two seminars a week will deal with the history and philosophy of Technical Institute Education as it applies to the over-all engineering manpower team. The recent report by the American Society for Engineering Education entitled "Characteristics of Excellence in Engineering Technology Education" will be analyzed in detail, and the importance of science-oriented programs for engineering technicians will be stressed. Specialists will also present lectures on such topics as curriculum development, financing, job opportunities, counseling, and evaluation procedures.

The program will include approximately 24 contact hours of class per week:

GE 221: 8-10 MWF and 8-11TT, 12 contact hours
GE 293: 1-3 MWF and 1-2 TT, 8 hours
GE 393: 2-4 TT, 4 hours.

Faculty

Jerry S. Dobrovolny, Professor and Head, Department of General Engineering, has been actively engaged in developing new curricula for teachers of engineering technology. He has headed five previous summer and academic year institutes for teachers, is co-author of a new text in basic drawing, has directed the preparation of several curriculum guides, and is chairman of the Engineering Technology Curriculum Advisory Committee.

Thomas C. Hartley, Associate Professor of General Engineering, has participated in previous summer institutes, has served as chairman of a committee developing student evaluation forms for teaching effectiveness, and has had extensive consulting experience. He is currently a senior member of the Office of Instructional Resources research staff, working on University-wide evaluation techniques. He is a co-author of Problems in Engineering Drawing and Geometry.

Ronald J. Placek, Assistant Professor of General Engineering, with a background in engineering mathematics and applied mechanics, has had practical industry experience as a tool and die maker, draftsman, and design engineer. He has taught applied mathematics in five previous institutes, and has been instrumental in developing technical curricula through the Engineering Technology Curriculum Advisory Committee.

Stipends and Housing

Each participant will be awarded a stipend of $600 for the eight-week session. To this will be added a dependency allowance of $120 for each of up to four dependents, so far as funds allocated for this purpose will permit. A travel allowance of up to $80 at 4¢ per mile will also be provided. No tuition will be charged by the University; health insurance and other fees will be paid by the U.S. Office of Education.

If desired, the Housing Division of the University will assist in securing approved community housing for married participants, and will attempt to locate members of the program close to each other. Within the University, one-bedroom housekeeping apartments will be available in the Arbor Suites at rates, including utilities, of $95 per month or $190 for the Institute period. For larger families, a few three-bedroom housekeeping units can be supplied at $115 per month including utilities. Arrangements can also be made to provide meals for family groups in nearby residence halls.

Shared living accommodations for single students in residence halls will cost approximately $5 per day including both room and meals, or $2 per day for room without meals. Residence-hall rooms for single occupancy will be $2.75 per day.

Institute classes will be limited to about 25 hours of a five-day week. The University has an excellent library, and varied recreational facilities are available both on the University grounds and within easy traveling range of the campus.

For further information write or call:

Prof. Jerry S. Dobrovolny, Director
117 Transportation Building
University of Illinois, Urbana
Telephone 217-333-2730

UNIVERSITY OF ILLINOIS--U.S. OFFICE OF EDUCATION

EIGHT-WEEK SUMMER TRAINING PROGRAM

FOR HIGH SCHOOL DRAFTING TEACHERS

APPLIED MATHEMATICS, GRAPHIC STATICS

AND

ADVANCED GRAPHICS

Supported by the

United States Office of Education
Under the Provisions of Section 4 (c)
Vocational Education Act of 1963

Held at the
College of Engineering
UNIVERSITY OF ILLINOIS
Urbana, Illinois

June 21 through August 14, 1965

Prof. Jerry S. Dobrovolny, Director
117 Transportation Building
University of Illinois, Urbana
College of Engineering

HIGH SCHOOL DRAFTING TEACHERS

UI-OFFICE OF EDUCATION EIGHT-WEEK SUMMER PROGRAM

in

Applied Mathematics - Graphic Statics

Advanced Graphics

Objectives

The primary purpose of the program is to assist faculty members of high school technical departments in extending and updating their subject-matter competencies, especially in drafting. Courses will be offered in applied mathematics, graphic statics and advanced graphics. Content of the courses will be adapted to the needs and interests of teachers who may desire to undertake more advanced assignments presenting machine design technology in technical schools or junior colleges.

Eligibility and Applications

Participants will be selected on the basis of previous teaching experience, and will be required to have taught drafting for a minimum of two years. Competition for positions will be open nationally through announcements to all State Offices of Public Instruction and Directors of Vocational Education. Demonstrated need for subject-matter upgrading and expressed desire for more challenging instructional assignments will be considered. Applicants will be expected but not required to have a Bachelor's degree in fields such as Vocational and Industrial Education, and should have high scholastic aptitude. It is not anticipated, however, that participants will have had formal academic training in the subject matters to be presented.

Related industrial experience will also be weighed as a criterion for selection, together with willingness to use the materials of the program and to participate in follow-up activities determining gains made and results achieved. Completed applications should reach the Director by June 1, and twenty-five appointments will be announced about June 7.

Academic Credit

Successful completion of the program courses will entitle the participant to eight semester-hours of credit. Participants who meet the admission requirements of the University of Illinois may count the courses toward undergraduate degrees and those who meet the requirements of the Graduate College may apply some of the credits toward a Master's degree in Industrial Education. All participants will be expected to take the Institute courses for credit as a condition of appointment.

In addition to specific content courses in applied mathematics, graphic statics, and advanced graphics, twice-weekly seminars will be held to discuss current problems in vocational and technical education. All courses will be of college level, and will cover topics usually treated in the second and third years of engineering curricula.

Course Content

Introduction to Design--GE 221M--3 hours.

Covers the most recent practices in production dimensioning, especially true positional tolerancing. Emphasis will be placed on dimensioning practices in the highly automated machine-tool industry today. The second half of the course will be devoted to the basic concepts of graphic statics, including vectors, free-body diagrams, and static force systems applied to machine members and frames. Both graphical and analytical solutions will be considered.

Other typical topics: datum planes, tolerance zones, surface quality specification and finish, fundamental concepts of equilibrium, concurrent and parallel forces in planes, and non-concurrent coplanar forces.

Mathematics Applied to Mechanical Systems--GE 293--4 hours.

Provides background needed to perform computations in statics and dynamics. The following topics will be emphasized: elementary functions, including trigonometric; exponents and radicals, logarithms, quadratic and simultaneous equations, properties of vectors, and systems of equations and determinants. Other topics: numerical computations, basic algebraic operations, right-triangle geometry, and continuation of trigonometry.

APPENDIX B - Inside Page

REQUEST FOR INFORMATION AND APPLICATION FORMS

1965 University of Illinois--U.S. Office of Education Summer Program for High School Drafting Teachers

Prof. J. S. Dobrovolny, Director
117 Transportation Building
University of Illinois, Urbana

Please send me further information on the Institute and the necessary application forms.

Name _____
last first initial

Occupation _____
title

Applicant's mailing address _____
street

_____
institution or school location

_____
city state zip code

Family Status: Single____; Married____; No. of children____; Other dependents____;

APPENDIX C - Front Page

APPLICATION FOR

EIGHT-WEEK SUMMER TRAINING PROGRAM IN ADVANCED GRAPHICS, GRAPHIC STATICS, & APPLIED MATHEMATICS

AT THE UNIVERSITY OF ILLINOIS, URBANA

JUNE 21 THROUGH AUGUST 14, 1965

Please answer all questions completely: (type or print)

1. Your name: Mr. Mrs. Miss (or:_____) _____
(Encircle one) (Last) (First) (Middle)

2. Social Security No._____ 3. Date of birth _____

4. Name of school in which you teach_____ Your Position _____

School address: No. and street _____ School phone No._____
City, State, ZIP code _____ Area code _____
Type of school: ☐ College ☐ Junior College ☐ High School ☐ Junior High ☐ Elementary ☐ Other
also: ☐ Public ☐ Private
Range of grades in this school (i.e.: "9-12", "7-8", etc.) _____ Total regular enrollment this term _____

5. Residential address: No. and street_____ Phone No._____
City, State, ZIP code_____ Area code_____

6. Check mailing address you wish used: ☐ School address (item 4) or ☐ Residential address (item 5)

7. Minimum one-way distance (highway and/or rail) from home to Institute:_____ miles

8. U.S. citizen: ☐ Yes ☐ No 9. Marital status: ☐ Single ☐ Married ☐ Widow(er) ☐ Divorced or separated

10. If you have a spouse, what is his or her occupation?_____

For *every dependent* who receives support from your individual income and who is listed as an exemption in your current Federal income tax return, please supply the information requested below. (Do not include yourself. Do not include your spouse if he or she has a gross income of $600 or more per year.) Add separate sheet if necessary.

NAME	AGE NEXT JULY 1	RELATIONSHIP TO APPLICANT	OCCUPATION	WHAT PERCENTAGE OF HIS YEARLY SUPPORT COMES FROM YOUR INDIVIDUAL INCOME?

Your individual yearly income constitutes what percent of the combined gross yearly income of yourself and spouse?_____%
How many dependency allowances do you request from the Training Program?_____(Four is the maximum that can be granted.)
If the persons listed above do not receive more than half of their support from your individual income, *please explain* the basis for your request for dependency allowances. (Use separate sheet.)

11. Employment Record. — List professional experience of the past 5 years in teaching and work related to teaching. *(List in reverse chronological order, giving present or last position first.)* (Add separate sheet if necessary.)

DATES	EMPLOYER	NATURE OF ACTIVITY
Current Position 19__ to 19__		

APPENDIX C - Back Page

12. Check your certification status: ☐ No certificate ☐ Temporary or emergency ☐ Permanent or fully accredited.
Certification deficiency (if any) is in ☐ Science or ma...matics ☐ Education ☐ Both ☐ Other.

13. College or university education:

Institution	School or Department	Years From—	Years To—	Degree	Major Subject	Minor Subject(s)

14. For *every* course studied in college or graduate school in the fields listed below, list (a) the course number as recorded on your transcript, (b) the descriptive title of the course, (c) the year it was taken, (d) number of semester-hours credit received (record amount in column U if the credit was undergraduate credit, and column G if it was graduate credit; if it was quarter-hours, multiply by 2/3 to convert to semester-hours), (e) grade received. *Include and MARK WITH AN ASTERISK* (*)

Course No.	Descriptive Course Title	Year Taken	Semester Hours U	Semester Hours G	Grade
	Mathematics and Engineering Science				
	COLLEGE ALGEBRA				
	TRIGONOMETRY				
	ANALYTICAL GEOMETRY				
	DIFFERENTIAL CALCULUS				
	INTEGRAL CALCULUS				
	DRAWING				
	DESCRIPTIVE GEOMETRY				
	STATICS				
	STRENGTH OF MATERIALS				
Total number of hours					

Course No.	Descriptive Course Title	Year Taken	Semester Hours U	Semester Hours G	Grade
	Other Sciences				
	CHEMISTRY				
	PHYSICS				
	BIOLOGY				
Total number of hours					

15. Discuss briefly your plans for professional training and your reasons for wishing to participate in this specific Training Program, sketching briefly the benefits you hope to derive from such participation and their relationships to any special problems you face in your teaching situation.

(Use separate sheet for answer)

16. Recheck this entire form to be sure that you have completed *every* item in accordance with the directions given at the beginning and the directions associated with individual items. Be sure that you have given full and correct infc...ation concerning your dependents (item 10). When this has been done, sign the following statement:

"I certify that the information given in this application is accurate and complete."

Signature_____ Date of application_____

PLEASE RETURN TO: Professor Jerry S. Dobrovolny, Director
Summer Training Program in Engineering Graphics
117 Transportation Building
University of Illinois, Urbana, Illinois

APPENDIX D

ROSTER OF PARTICIPANTS
UI-USOE EIGHT-WEEK SUMMER TRAINING PROGRAM
FOR DRAFTING TEACHERS

June 21 - August 14, 1965

Andrews, Robert C.
6 Starlight Avenue
Chelmsford, Massachusetts
Lowell Technological Institute
Lowell, Massachusetts

Banker, Deane T.
3707 Panorama Drive
Hutchinson, Kansas
Hutchinson Junior College
Hutchinson, Kansas

Bauer, William R.
82 Staley Drive
Hamburg, New York
Dunkirk Industrial High School
Dunkirk, New York

Bye, Earl A.
421 State Street
Alpena, Michigan
Alpena Public Schools
Alpena, Michigan

Desmarais, Robert P.
2927 25th Avenue
Kenosha, Wisconsin
Washington Junior High School
Kenosha, Wisconsin

Dumas, Paul S.
51 Mill Street
South Hamilton, Massachusetts
Somerville Trade High School
Somerville, Massachusetts

Elkins, Melvin J.
1936 Wensley
El Centro, California
Imperial Valley Junior College
Imperial, California

Faust, John R.
R.F.D. #2
Plymouth, New Hampshire
Plymouth High School
Plymouth, New Hampshire

Hankins, Bruce
2512 South West 54th
Oklahoma City, Oklahoma
U.S. Grant High School
Oklahoma City, Oklahoma

Huddleston, Harold T.
132 Williams Street
Middletown, Connecticut
Windham Regional Technical School
Willimantic, Connecticut

Hunsbuscher, Richard J.
920 Fulton Street
Antigo, Wisconsin
Antigo Junior-Senior High School
Antigo, Wisconsin

Jacobson, John A.
2284 Bellevue Place
Northbrook, Illinois
New Trier High School
Winnetka, Illinois

Johnson, Bertil H.
511 10th Place
Kenosha, Wisconsin
Lincoln Junior High School
Kenosha, Wisconsin

Johnson, Raymond H.
3114 Northwestern Avenue
Racine, Wisconsin
Washington Park High School
Racine, Wisconsin

Johnston, Lonnie F.
516 West 4th Street
North Little Rock, Arkansas
North Little Rock High School
North Little Rock, Arkansas

Kotschevar, Richard G.
215 South Spruce
Thief River Falls, Minnesota
Lincoln High School
Thief River Falls, Minnesota

Lowe, Charles E.
728 Banks Avenue
Aiken, South Carolina
Kennedy Junior High School
Aiken, South Carolina

McKeage, George F.
217 Cameron Street
Manchester, New Hampshire
Manchester Memorial High School
Manchester, New Hampshire

Miller, Charles E.
77 Bel-Aire Drive
Springfield, Illinois
Springfield High School and Junior College
Springfield, Illinois

Paradeses, Stike D.
Route #1, Box 468
West Columbia, South Carolina
Heyward Gibbes Junior High School
Columbia, South Carolina

Peterson, Robert S.
1119 Avenue E
Billings, Montana
Billings Senior High School
Billings, Montana

Sepich, Joseph A., Jr.
Lot #3, 3760 East Williams Street Road
Decatur, Illinois
Stephen Decatur High School
Decatur, Illinois

Shadoan, Russell L.
Milligan Highway
Johnson City, Tennessee
East Tennessee State University
Johnson City, Tennessee

Shafer, Charles A.
309 North Edwin Street
Champaign, Illinois
Franklin Junior High School
Champaign, Illinois

Urbanick, Byron W.
41 North Broadview
Lombard, Illinois
Oak Park - River Forest High School
Oak Park, Illinois